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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/593,444	02/05/2007	Makiko Kitazoe	029567-00011	8995

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EXAMINER	
MILLER, JR, JOSEPH ALBERT	

ART UNIT	PAPER NUMBER
1715	

NOTIFICATION DATE	DELIVERY MODE
04/06/2011	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

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Office Action Summary	Application No.	Applicant(s)	
	10/593,444	KITAZOE ET AL.	
	Examiner	Art Unit	
	JOSEPH MILLER JR	1715	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *18 March 2011*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-18* is/are pending in the application.

4a) Of the above claim(s) *1-7* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *8-18* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 03/18/2011 has been entered.

Claim Rejections - 35 USC § 112

The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 8-18 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claim 8 includes that the reactive vessel is "capable of performing vacuum pumping" in the preamble. It is not particularly clear:

- whether any active step of vacuum pumping actually occurs within the method, or,
- exactly what is meant by this description – as written it implies that the vessel itself is capable of acting as a pump.

It would be further clearer to also amend the wording such that the vessel is a "reaction" vessel versus a "reactive" vessel, since the latter implies the vessel itself may partake in the reaction.

Claim Objections

Claim 8 is objected to because of the following informalities: claim requires a gas containing nitrogen component – this apparently should read "a gas containing a nitrogen component" lest it mean that there is a nitrogen component which contains a gas. Appropriate correction is required.

Claim Rejections - 35 USC § 103

The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

Claims 8-18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Yamoto (2002/0104477) in view of Wang (2004/0121085) and alternatively further in view of Matsuda (5,808,316).

Yamoto teaches a method of forming a SiN film on a substrate, the method comprising using an exothermic catalyst body to activate silane, ammonia, and hydrogen gases ([0148] and Fig. 1). The chamber is capable of being vacuum pumped, as understood by a pressure of 13.3Pa [0148].

Yamoto therefore teaches a film-forming step of forming a SiN film using a catalyst body and the named gases, but does not teach forming a laminated film of multiple layers or surface treating each layer with treatment steps including hydrogen gas active species and active species of the gas containing nitrogen component.

Wang teaches a method of forming a SiN film, using various silane gases and ammonia [0016-0026]. Wang teaches that the deposited films may be treated with a nitrogen containing source gas (NH3) and/or a hydrogen gas after the deposition step [0033] in order to remove hydrogen ([0034], [0020]). The either one or both gases is applied to the SiN substrate after being contacted against a "hot wire" to activate the gas [0033]. Based on the language that *either or combinations* of the gases may be applied, the teachings suggest embodiments wherein each gas would be applied (separately) to the film surface as an effective manner of treating the film to remove hydrogen. It would have been obvious to one of ordinary skill in the art at the time of the invention to apply multiple (i.e. separate) steps of applying one of each H2 and NH3 to the SiN surface based on Wang's teachings that either or both of the gases is operable for removing contaminants from deposited SiN.

[Interpretation of the use of multiple treatment steps is further supported by Wang's suggestion that the nitrogen source gas (exemplified as NH3 [0025]) may be applied to the as-deposited film in order to remove hydrogen [0028]. Though the optional treatment does not explicitly teach that the nitrogen source gas described in

[0028] is activated, per [0033] the activation of that nitrogen source gas (previously exemplified as NH3) for the treatment step would be an understood embodiment.]

It would have been obvious to one of ordinary skill in the art at the time of the invention to apply the post SiN deposition treatment steps, including the separate steps of treatment using the activated nitrogen containing gas and separately activated hydrogen gas, of Wang to the SiN deposition method of Yamoto, as the treatment steps would allow one to reduce the hydrogen content of the film, which is desirable per the teachings of Wang.

The combined teachings therefore suggest a film-forming step of forming a SiN film using a catalyst body and the named gases and surface treating the SiN film with treatment steps including hydrogen gas active species and active species of the gas containing nitrogen component, but do not teach forming a laminated film of multiple layers, wherein each layer is treated.

Wang further teaches that a 200A thick silicon nitride film is useful for 65 nm technology [0037] and that hydrogen radicals can penetrate less than 100 angstroms deep into the film [0035]. Therefore if film of 200A is required, i.e. as for a 65nm technology node, multiple layers are deposited in order to achieve desired thickness.

It would be obvious to iteratively repeat the steps of deposition and surface treatments, as taught by Wang, so that a SiN film could be formed with effective

removal of the hydrogen, when combining the catalytic CVD deposition method of Yamoto with the surface treatment process of Wang.

Wang teaches a thermal process in general (and not specifically a catalytic process). Examiner takes the position that one of ordinary skill would have an expectation of undesirable hydrogen content even with the silane precursor suggested by Yamoto, particularly in view of Wang's disclosure that a film deposited at "low temperature" (wherein the substrate is less than 550 C [0005-6]) is especially susceptible to poor film quality due to hydrogen level [0019] and Yamoto's suggestion that the catalytic method is a 'low temperature" method in that the substrate may be held around 350 C, for example. Nonetheless, the additional teachings of Matsuda are alternatively presented.

Matsuda teaches that silicon containing films may be formed using silane gases such as SIH4 or chlorine containing silane gases (col 5, lines 33-47).

In further view of Matsuda, it would have been obvious to one of ordinary skill in the art at the time of the invention to apply the use of any of the gases suggested by Matsuda in the catalytic-CVD method of Yamoto as one would expect to operably form a silicon-containing film using chlorine containing silane gases based on Matsuda's suggestion that such gases are operable in such catalytic processes.

The arguments presented above over Yamoto in view of Wang would be applied as noted above – with the additional suggestion of applying the chlorine containing

gases of Wang – and the added/alternative motivation of removing Cl from the deposited SiN film.

Regarding claims 8 and 9, it would be obvious to repeat the treatment steps to effect a usable film. the teachings of Wang are not particular limiting, particularly in view of an optional nitrogen containing gas treatment step as noted and the suggested that either NH3 or H2 or combinations thereof are operable in removing contaminants. It is further noted that Wang teaches that the steps are result effective in reaching a desired level of contamination in the film [0034]. While paragraph [0034] suggests a continuation of the process to achieve a desired low level, the embodiments suggested by Wang's teaching of different and continued steps would be understood to include repeating of any of the described treatment steps to achieve such a goal.

Regarding claim 10, Wang teaches continuous formation of the film including treatment steps for a number of layers [0035, 0037].

Regarding claim 11, Yamoto teaches the discharge of the gases from the process chamber [00149] taught by Yamoto is a vacuum pump [0065].

Regarding claim 12, the nitrogen step adds nitrogen to the film and the hydrogen step depletes hydrogen (or chlorine) from the film.

Regarding claim 13, the combined teachings as presented above teach a final step of hydrogen or NH3 treatment – each of which include a film component.

Regarding claim 14, Wang teaches that specifically if HCD gas is use, an inert carrier gas such as nitrogen may be used for a deposition process [0025].

Examiner takes official notice that it would be known to use a carrier gas with any silicon source gas; as such, it would have been obvious to one of ordinary skill in the art at the time of the invention to apply the use of an inert / nitrogen gas along with the silicon source used in the deposition process.

Furthermore, particularly related to the application of Matsuda, the use of HCD gas is encompassed in the combined teachings as a Cl-containing silane gas.

Regarding claim 15, per the teachings above, the teachings would be applicable either to silane gas as the silane precursor or a chloride (i.e. halide) of silane, particularly in the case of the latter in the further view of Matsuda.

The teachings as described above also teach a hydride of N (i.e. NH3).

Regarding claim 16, the surface treatment gases taught by Wang are H2 and NH3, as described above.

Regarding claim 17, all limitations are taught as per above, see particularly claims 8, 13, 15 and 16.

Regarding claim 18, Wang teaches the viability of H2 and/or NH3 treatment steps, and, per examiner's position, a mix of various treatment steps using either or both of the gases. It would have been obvious to one of ordinary skill in the art at the time of the invention to apply either of the H2 and/or the NH3 steps as a final step.

Response to Arguments

Applicant's arguments filed 03/18/2011 have been fully considered but they are not persuasive.

Examiner does not agree that the combined teachings of Wang and Yamoto do not teach "a surface treating step of surface-treating the thin film for each unit layer by the hydrogen gas active species; another surface treating step of surface treating the film for each unit layer by the active species of the gas containing nitrogen component" as argued on p8.

The amended claims do not require the teachings of Nguyen and Raaijmakers, therefore only the teachings of Wang and Yamoto have been reapplied.

The teachings of Wang teach all elements of the two surface treating steps for treating a SiN film - but lack the specific teaching of forming an SiN film form using a catalytic CVD method.

As noted above, Wang teaches that applying H2 and/or NH3 gases activated by a hot wire are effective for removing hydrogen from a deposited film. One of ordinary skill would understand that if either gas is operable, one could effectively apply both – either in the same treatment step or in alternative treatment steps, the teachings are not so limited as to restrict the treatment steps. Yamoto is again applied for teaching the formation of a SiN using a catalytic CVD method. The film deposition process would be performed in "unit layers" when desired to form a SiN film greater than ~50A per the teachings of Wang, based on the ability of the reactive gas to penetrate into the deposited film to remove hydrogen.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to JOSEPH MILLER JR whose telephone number is (571) 270-5825. The examiner is on a flexible schedule, but can normally be reached at least Mon - Thurs, 6am to 3:30pm. Other times as required are available for interviews.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Timothy Meeks, can be reached on 571-272-1423. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

/JOSEPH MILLER JR/
Examiner, Art Unit 1715

/Timothy H Meeks/
Supervisory Patent Examiner, Art Unit 1715